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# Perspectives on the Delta Waterfowl Research Station-Ducks Unlimited Canada Marsh Ecology Research Program

Henry R. Murkin
*Delta Waterfowl Research Station, Manitoba*

Bruce D. J. Batt
*Delta Waterfowl Research Station, Manitoba*

Patrick J. Cadwell
*Ducks Unlimited Canada*

Craig B. Davis
*Ohio State University*

John A. Kadlec
*Utah State University*

***See next page for additional authors***

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**Abstract**

Present wetland management has been developed largely on a trial and error basis (Figure 1 ). The effects of many important environmental variables on wetland productivity 253 are not known, consequently management results have not been predictable with a high degree of accuracy (Weller 1981 ). Many marsh management techniques have been described; however, consistently successful marsh management requires a more comprehensive understanding of the structure and function of wetland systems. Although there have been numerous observational studies, major advances in our understanding will result from tightly controlled experimentation which permits the integration of simultaneous research efforts by a number of different scientific disciplines (Reichle 1975, Weller 1978). Because wetlands are temporally dynamic, this type of multi-disciplinary ecosystem analysis must also span a number of years to document the annual and long-term variability within the system. By better understanding the structure and function of wetlands, managers will be better able to design management techniques and strategies suited to their particular situation and therefore realize greater success in manipulating the productivity of these systems (Figure I).



**Disciplines**

Botany | Ecology and Evolutionary Biology | Natural Resources Management and Policy | Terrestrial and Aquatic Ecology

**Comments**

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**Authors**

Henry R. Murkin, Bruce D. J. Batt, Patrick J. Cadwell, Craig B. Davis, John A. Kadlec, and Arnold G. van der Valk

# *Advances in Wetland Research and Management*

*Chairman:*

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Department of Fisheries and Wildlife
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Logan, Utah

*Cochairman:*

HENRY R. MURKIN
Research Biologist
Delta Waterfowl Research Station
Portage la Prairie, Manitoba, Canada

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**Henry R. Murkin and Bruce D.J. Batt**
*Delta Waterfowl Research Station, R.R.1*
*Portage la Prairie, Manitoba R1N 3A1*

**Patrick J. Caldwell**
*Ducks Unlimited Canada*
*1190 Waverley St.*
*Winnipeg, Manitoba R3T 2E2*

**Craig B. Davis**
*School of Natural Resources*
*Ohio State University*
*Columbus, Ohio 43210*

**John A. Kadlec**
*Department of Fisheries and Wildlife*
*UMC 52*
*Utah State University*
*Logan, Utah 84322*

**Arnold G. van der Valk**
*Department of Botany*
*Iowa State University*
*Ames, Iowa 50011*

## Introduction

Present wetland management has been developed largely on a trial and error basis (Figure 1). The effects of many important environmental variables on wetland productivity are not known, consequently management results have not been predictable with a high degree of accuracy (Weller 1981). Many marsh management techniques have been described; however, consistently successful marsh management requires a more comprehensive understanding of the structure and function of wetland systems. Although there have been numerous observational studies, major advances in our understanding will result from tightly controlled experimentation which permits the integration of simultaneous research efforts by a number of different scientific disciplines (Reichle 1975, Weller 1978). Because wetlands are temporally dynamic, this type of multi-disciplinary ecosystem analysis must also span a number of years to document the annual and long-term variability within the system. By better understanding the structure and function of wetlands, managers will be better able to design management techniques and strategies suited to their particular situation and therefore realize greater success in manipulating the productivity of these systems (Figure 1).

In response to the need for long-term multi-disciplinary research in freshwater wetlands, the Delta Waterfowl Research Station and Ducks Unlimited Canada embarked on their joint Marsh Ecology Research Program (MERP) in 1979 (Batt et al. 1983). A scientific team from a variety of disciplines (hydrology, plant ecology, invertebrate ecology, vertebrate ecology, nutrient dynamics, marsh management) was assembled to design and oversee a long-term experiment on the effect of water level manipulations on northern prairie marshes. MERP has three general program objectives: (1) to understand the ecological processes affecting the distribution and abundance of wildlife and plant species in northern prairie marshes (Development of New Information); (2) to improve practical management of wetlands by providing managers with a better understanding of the structure and function of wetland systems (Communication); and (3) to encourage students to seek training and careers related to wetland research and management (People).

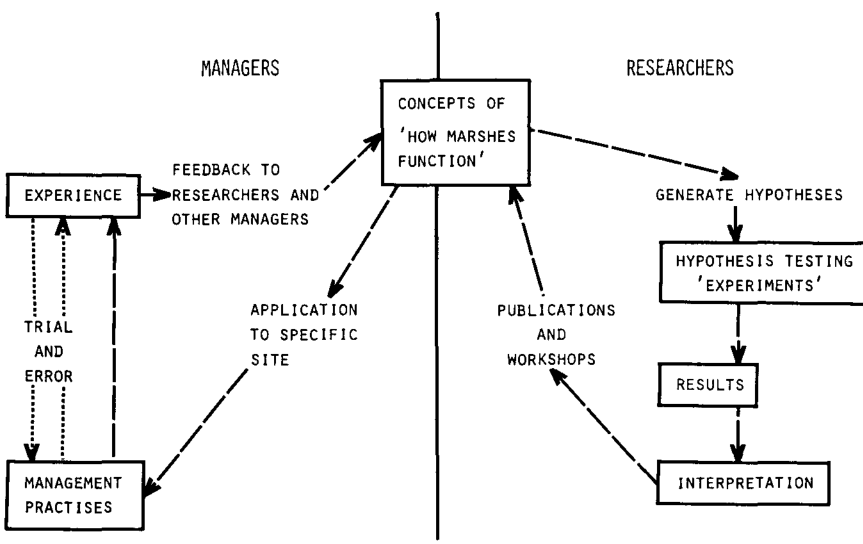


Figure 1. Hypothetical model of the interaction between researchers and managers in the development of successful marsh management practices.

## Development of New Information

The MERP Scientific team (authors of this paper) is responsible for the development and supervision of the overall research program. Each team member oversees the field procedures, data collection, analyses, and publication of results in their area of responsibility.

The primary research objective of MERP is to develop new information on the structure and function of northern prairie marshes. These marshes exhibit changes in productivity which correspond to the wet-dry cycles characteristic to the northern prairie environment (Weller and Frederickson 1974, van der Valk and Davis 1978). The wet-dry cycle is the fluctuation between drought (dry) and flooded (wet) conditions resulting from variation in annual precipitation. The changes in wetland productivity during this wet-dry cycle have been described by van der Valk and Davis (1978). Two early MERP contributions (van der Valk 1981, 1982) have presented models and discussions of the vegetation response to the wet-dry cycle.

Without understanding the mechanisms involved, marsh managers have long used water level manipulations to manage the productivity of prairie marshes (Kadlec 1962, Harris and Marshall 1963, Meeks 1969). Because water regime appears to be the dominant factor regulating the productivity of these systems and one which can be practically manipulated by managers, the MERP Scientific Team decided that early investigations would concentrate on the effect of varying water levels on overall wetland productivity. The movement and storage of the three crucial macro-nutrients (nitrogen, phosphorus, and carbon) will be monitored at all levels of the ecosystem. In many wetlands, either nitrogen or phosphorus are often thought to be limiting productivity, hence this effort should lead to a better understanding of the underlying relationships regulating the productivity of prairie wetlands (Kadlec 1979). The general research objective is to quantify the movement and storage of nitrogen, phosphorus and carbon in the marsh ecosystem during various stages of the wet-dry cycle.

The more specific research objectives are:

1. Hydrology—to estimate the terms of the water budget during all phases of the wet-dry cycle: surface water in, surface water out, ground water in, ground water out, change in storage, precipitation, and evapotranspiration.
2. Water chemistry—to estimate the concentrations of carbon, nitrogen, phosphorus, and chloride in both surface and interstitial water and to monitor the movement of these nutrients in the water budget throughout the wet-dry cycle.
3. Invertebrates—to calculate production of aquatic invertebrates (nekton and benthos) during the wet-dry cycle through estimation of standing crops and turn-over rates.
4. Macrophytes—(a) to estimate net annual above and below ground macrophyte production through estimates of biomass; (b) to estimate annual uptake and release of nitrogen and phosphorus by living macrophytes.
5. Macrophyte litter—(a) to estimate annual production of standing emergent, standing submersed, and detached macrophyte litter; (b) to estimate the annual net loss and/or uptake of nitrogen and phosphorus in the standing emergent, standing submersed, and detached litter.
6. Vertebrates—to calculate the transfer of carbon, nitrogen, and phosphorus by vertebrates.

### *Experimental Design*

The MERP study area is located on the Delta Marsh in south-central Manitoba. The actual experimental site consists of 10 contiguous 4–6 ha (10–15 acre) marsh units created by building a series of dikes along the north side of the marsh (Figure 2). Besides the diked cells, two undiked areas of similar size within the Delta Marsh are monitored as controls. Due to the long-term nature of the experiment, the dikes are designed to last at least 20 years with annual maintenance to control erosion and muskrat damage. Each experimental marsh is equipped with a water control structure and electric pump to manipulate and maintain water levels.

The experimental marshes were randomly assigned the schedule of water levels shown in Table 1. Following a year of baseline data collection (1980) all cells were subjected to a 2-year "conditioning" period. Conditioning involved flooding the marshes to a depth of one meter within the cattail (*Typha* spp.) stands. This prolonged flooding was intended to set all marshes to the "lake marsh" stage described by van der Valk and Davis (1978). Setting all experimental marshes to the lake marsh stage during conditioning was an attempt to reduce the variability between the marshes prior to the main experiment beginning with drawdown. The conditioning period was also a unique opportunity to study the marsh response to prolonged above-normal flooding (for example see Murkin 1983a). Conditioning levels killed most of the emergent and submersed vegetation and resulted in the decompostion of much of the original plant litter. These levels also similate the natural high water levels that occurred in the Delta Marsh prior to the 1960s.

Following drawdown the cells will be reflooded to three different levels (Table 2). The exact levels of reflooding in 1985 will be determined following a detailed analysis of the contour levels and other data from the conditioning period. Under natural conditions northern prairie marshes cycle through varying stages of productivity depending on water levels (van der Valk and Davis 1978). It is hypothesized that the rate of cycle or change in productivity is determined in large by the water depth within the marsh basin. Reflooding the experimental marshes to a variety of water depths (Table 2) should result in a variety of cycling rates within the study area. Monitoring the movement and storage of nutrients of marshes cycling at different rates will provide important insights into the factors controlling wetland productivity.

### *Long-term Monitoring Program*

The scientific team has designed a program of standardized methods to monitor the system throughout the period of study. These techniques are detailed in a procedures manual (Murkin 1983b). Most of the procedures used have been adopted from other investigators, but all have been fully field-tested and modified to suit the needs for efficiency, economy, and practicality required in long-term, large scale replicated research (for examples see Murkin et al. 1983, Wrubleski and Rosenburg 1984). Publication of the MERP procedures manual (Murkin 1983b) will aid in the standardization of techniques used in marsh ecology research and will also allow critical evaluation of MERP procedures by other scientists in the field. As experience is gained, improvements in sampling techniques and schedules are incorporated into the long-term monitoring program as needed. Progress in marsh research will be more rapid if techniques used by various investigators are comparable. We offer our techniques in this format to encourage others to use them and thereby make all of our work more comparable and therefore more valuable.

Data obtained through a program of standardized techniques on a series of marshes

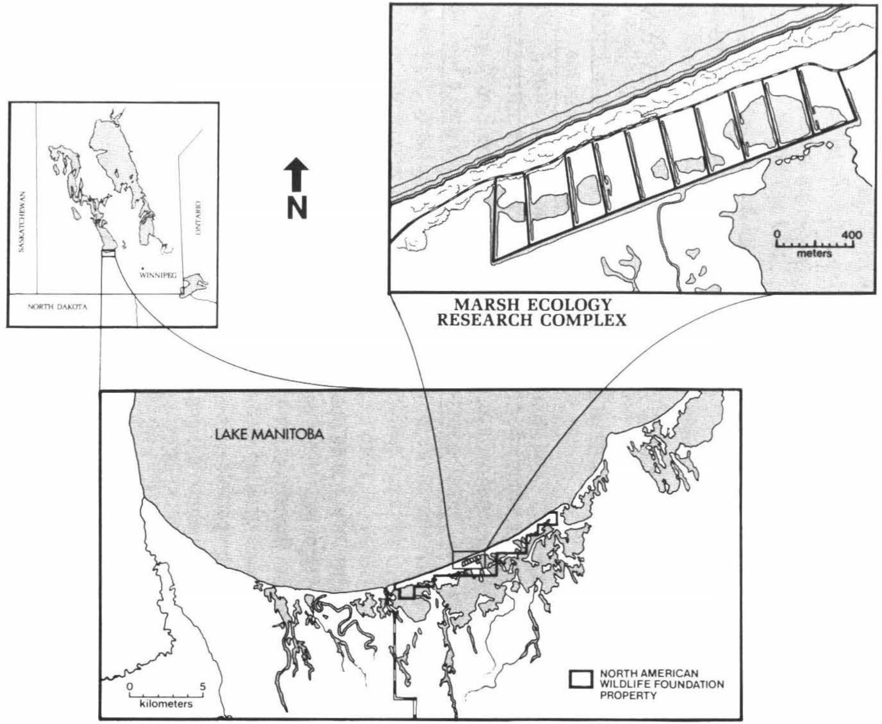


Figure 2. The March Ecology Research Program experimental marshes on the Delta Marsh in southcentral Manitoba.

Table 1. Schedule of water levels for MERP experimental marshes.

| Year | Water levels |
|---|---|
| 1980 | All 10 marshes normal levels of Delta Marsh<br>(baseline monitoring of all marshes) |
| 1981 | 8 marshes flooded to "conditioning" level<br>2 marshes normal levels of Delta Marsh |
| 1982 | 10 marshes at "conditioning" level |
| 1983 | 8 marshes drawn down<br>2 marshes remain at "conditioning" level |
| 1984 | 10 marshes drawn down |
| 1984–89 | 3 marshes reflooded to shallow level<br>4 marshes reflooded to medium level<br>3 marshes reflooded to deep level |

Table 2. Number of experimental marshes within each of proposed water levels following drawdown.

| Drawdown duration (years) | Water level after drawdown | | |
|---|---|---|---|
| | Shallow | Medium | Deep |
| 1 | — | 2 | — |
| 2 | 3 | 2 | 3 |

undergoing simultaneous experimental manipulations will provide systematic information on the response of the ecosystem to water level manipulations. Items monitored for this long-term study correspond to the seven research objectives mentioned earlier. The list of long-term monitoring items is detailed in Batt et al. (1983) and Murkin (1983b). The basic strategy is to collect a comparable data set from year to year in each experimental marsh for each of the major components being monitored.

### *Short-term Studies*

Besides the long-term monitoring, an important aspect of MERP are the short-term studies. As the long-term program proceeds, many hypotheses are generated that are suitable for short-term studies. Short-term studies are normally conducted and funded through the graduate research program of the Delta Waterfowl Research Station. To this point in time, graduate studies have dealt with the following topics: the role of seed banks in the vegetation development on drawdown surfaces (Pederson 1981, 1983), effects of nutrient litter quality on macroinvertebrate production (Nelson 1982), macroinvertebrate response to prolonged flooding of marsh habitat (Murkin 1983a), the effect of habitat type on the emergence of Chironomidae (Wrubleski 1984), the effects of invertebrates on macrophyte litter decomposition, the effect of water level fluctuations on productivity and biomass of algae assemblages, waterfowl and plant production in marshes dominated by whitetop grass (*Scholochloa festucacea*), reestablishment of perennial emergent macrophytes during drawdown of a lacustrine marsh, and chironomid recolonization of marsh drawdown surfaces following reflooding. Other short-term studies are anticipated as more questions are generated by the long-term monitoring program. There are also opportunities for new investigators to develop affiliations with MERP as the overall program develops.

## Communication

One hindrance to successful wetland management has been the lack of communication between the management and research communities. An important objective of MERP is to bridge this gap and to make researchers aware of the information needs of managers and to ensure that the information produced by MERP and other related studies leads to a better understanding of the dynamics of wetlands by both managers and the research community. While the value of published information to other researchers is obvious, managers often do not use or understand the information generated by research. This problem stems from lack of training, lack of access to the information, job descriptions that do not allow time for review of the literature, and-so-on. MERP generated information will appear in the scientific literature but also as management publications geared to field personnel (see Pederson 1981). Seminars and workshops between MERP researchers and wetland managers have been held and more are planned. MERP itself will not generate many specific management techniques; however, by increasing the understanding of wetland managers, they will be better able to develop management techniques suitable to the specific marshes with which they work (Figure 1).

This is an important change from previous management-oriented research where the results of a single management technique are monitored. Each wetland system is different based on its geographic location and resulting environmental variables. A technique may work in one region and not in another. Rather than monitoring the results of a single technique in a specific geographic area, researchers should channel their efforts to achieve a general understanding of the structure and function of marshes and then ensure that their work leads to a better understanding of wetland processes by the management community. Managers are most aware of the environmental conditions and unique physical characteristics of their regions, so with improved understanding of their system would be better equipped than anyone to develop successful marsh management programs (Figure 1).

## People

MERP will also expose students to training in basic wetland ecology. To date over 90 students from the U.S. and Canada have gained wetland experience on MERP. Some of these people will become managers and be much better prepared to take advantage of the information available on prairie wetlands and therefore realize greater success in the management of their systems. Others will be involved in wetland research and will be more aware of the need to better understand the dynamics of freshwater wetlands in general and to communicate their results to managers to ensure successful management of our wetland resources. While many of the students will not be wetland specialists in their professional careers, most will be employed somewhere in the field of conservation. Wetlands are the focal points for many conservation decisions and all of these people will be better prepared to influence proper decisions based on insight gained at this stage of their professional careers.

## The Future

MERP is entering the most important phase yet because the data accumulated to date are being analyzed, published, and made available to the research and management communities. Early major achievements such as the development of a model detailing the vegetation response to the wet-dry cycle (van der Valk 1981) or the first replicated water budgets for small prairie marshes (Kadlec 1982) show that this process is well underway, and the rate of production of both scientific and management contributions should escalate markedly during the next few years. There are numerous indications that MERP is on a productive course and achieving near its potential even at this early stage.


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